THE CHANGING FOREST FLORA OF THE OZARKS

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In this work the first time-lapse study on the forest flora of the northern Ozarks is reported. Brenner (1942) has shown the influence of the soils and the underlying rock strata upon the forest flora within a portion of the area covered, but the present study includes additional plant habitats and may be more representative. Recently the current associations were compared with those of an earlier map (Anderson, 1938), and the observed changes are here recorded.

GEOLOGY OF THE AREA

The area under discussion consists of about 650 acres in the Arboretum of the Missouri Botanical Garden at Gray Summit, Franklin County, R. 2 E., T. 43 N., Mo. It is a rectangular area lying within the rugged hills bordering the Meramec River, in the northern limits of the Ozark uplift, a region of dolomitic limestones weathered into a topography of moderate relief. A correlation of the logs from deep wells on the area has placed the underlying rocks in the Jefferson City, Cotter, and Powell formations of the Canadian Series, in the lower Ordovician Period (fig. 1.).

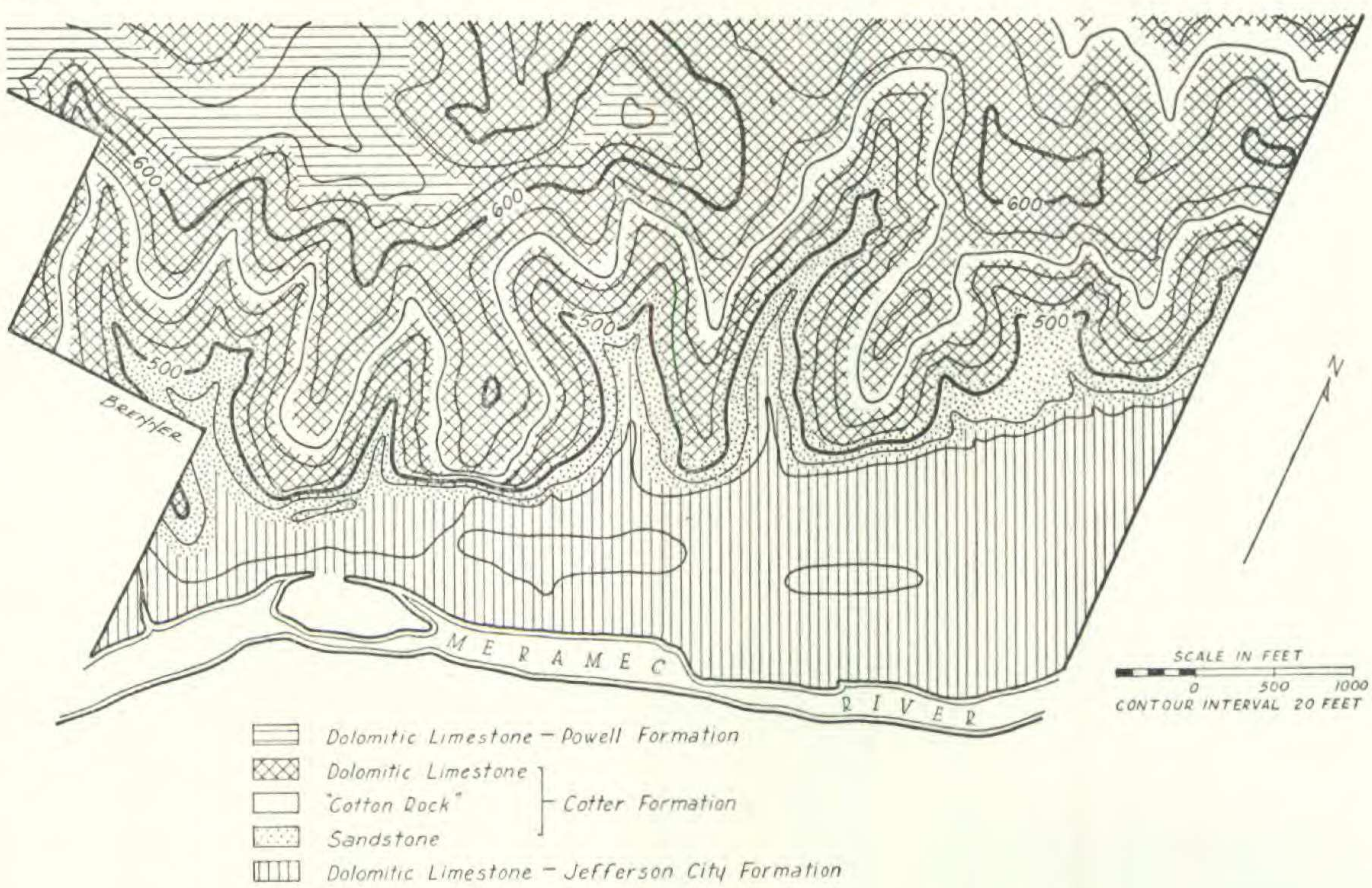

Fig. 1. The rocks underlying the Forest Preserve of the Arboretum.

Jefferson City Formation.—This formation forms the lowest outcrop to be found in the area, and is represented by a phase of dense gray-brown, oolitic, dolomitic limestone. This stratum outcrops at comparatively low elevations, and the

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greater portions of it are covered with talus debris, considered to have only a small influence on the forest cover.

Cotter Formation.—The Cotter, lying unconformably upon the Jefferson City formation, is composed primarily of dolomitic limestones with sandstone phases of one to several feet in thickness, and thin shale lenses. The base of this formation is a gray-brown sandstone, 37 feet in thickness, and of interest because several perennial springs have their origin in this stratum. The sandstone is succeeded by a phase of dense, massive, slightly dolomitic limestone, 34 feet in thickness. The remaining 91 feet is composed of succeeding strata of medium-grained, loosely cemented sandstones; dense, oolitic, slightly dolomitic limestones; and relatively thin strata of pure dolomite, locally known as "cotton rock." In chemical content (a double carbonate of magnesium and calcium), in high porosity, and in degree of fractibility, the cotton rock may have a more direct influence upon the flora than any other stratum. The occurrence and distribution of glade floras have been shown to be directly related to these cotton-rock strata (Erickson, Brenner, Wraight, 1942).

Powell Formation.—The Powell is represented by somewhat thinly bedded strata of limestone, chert, dolomite, and sandstone. There are but few outcroppings, since the formation is almost completely overlain by the mantle of Union Silt Loam. The predominance of cotton rocks which permit the rapid percolation of water creates a "dry" appearance in the forest during most of the growing season. The ease with which water moves through these rocks is shown by the numerous springs, and by the great amount of seepage water to be found in the valleys in wet seasons. This rapid percolation of ground water does not encourage the deep penetration of tree roots into the rocks in search of water. The influence of the rocks is further reflected in the slow growth of the trees. The dolomitic rocks, because of their slow rate of decomposition (Hilgard, 1910; Lutz and Chandler, 1947), offer only small quantities of the minerals necessary for the growth of plants. Feeding roots seem to be concentrated primarily in the shallow soil mantle, where the decomposing organic matter offers greater quantities of nutrients. The effect of these two factors is evidenced in the glades which are devoid of forest trees.

SOILS OF THE AREA

The rocks, high relief, and the various exposures and angles of slopes, together with the pattern of land use, present a complexity of factors reflected in an equally complex "soil picture." Based on local peculiarities, the soils are divisible into two major groups: residual and alluvial. Because of the "upland" nature of the area, the alluvial soils are of relatively little importance and will be treated only briefly (fig. 2).

Union Silt Loam.—The Union Silt Loam represents the most important soil group by reason of its greater areal extent and its ability to support the better timber types at considerably faster growth rates. The soil is a brown to grayish-

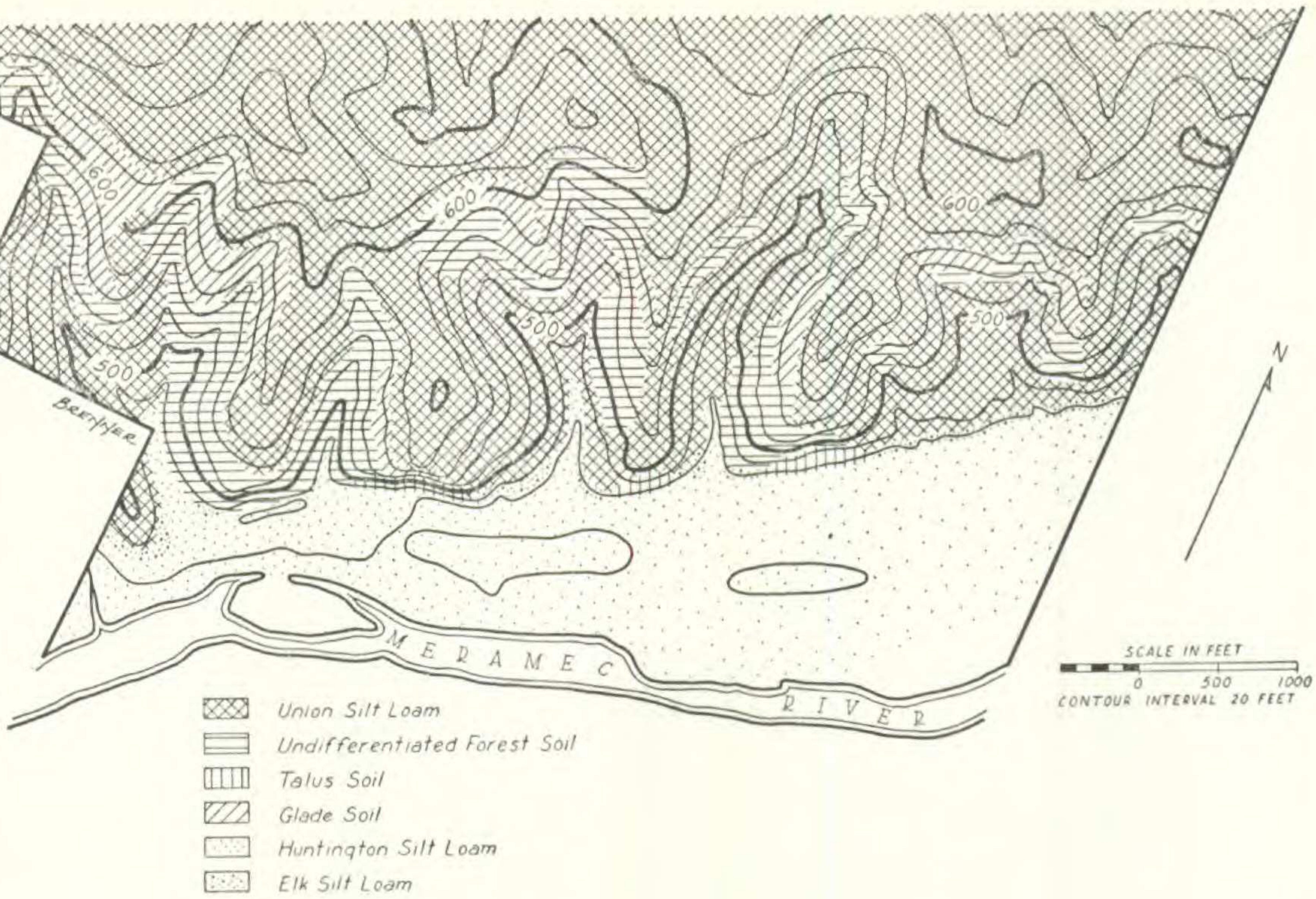

Fig. 2. Principal soil types of the Forest Preserve of the Arboretum.

brown, mellow silt loam, 6–8 inches deep, grading into a light brown or yellowish-brown, friable, silty clay of crumb-like structure, with a nut-like subsoil at greater depths. The fine silty nature of this soil and its great angle of slope make it an easy prey to erosion, which, however, can be controlled by planned forest management.

The Union Silt Loam in its typical form is apparent as the mantle covering the ridges. On some steeper slopes and small localized areas the soil is of a cherty nature and should be classed as Clarksville Stony Loam. However, because of the localized nature of this cherty soil and the history of land use of the area, the authors believe that it represents subsoil of the Union Silt Loam, exposed through erosion induced by early land use.

Rough Stony Land.—Extensive areas of the Arboretum have a soil generally referred to in soil surveys as Rough Stony Land (Vanatta and Lewis, 1911). The forest types found here have suggested the advisability of further division of this soil into four subtypes based upon site and mode of origin: Undifferentiated Forest Soil, Talus Soil, Glade Soil, and Alluvial Soil. The group is represented by soils which, because of direction and steepness of slope, have been retarded in development. Shallow, rocky, and of high organic content, they are entirely without distinguishable horizons.

The Undifferentiated Forest Soil is found chiefly on south and western hillsides, and may be from a fraction of an inch to several inches in depth. The soil mantle lies immediately upon the bed rock, has a high organic content, and contains an abundance of rock fragments. Exposure of these slopes to sere late summer winds has discouraged herbaceous vegetation. This, together with the high angle of slope, has caused excessive erosion, resulting in an almost permanent juvenile state. The forest type listed as "Transitional" is almost entirely confined to this soil.

The Talus Soil is practically identical with the Undifferentiated Forest Soil in composition, but differs in its greater depth and in the constant movement of the mass through settling. These differences, along with a relatively low water table during drought, has discouraged the growth of good timber trees.

The Glade Soil represents a distinct type of shallow soil mantle derived from dolomitic rocks. The soil has a high organic content, but the underlying highly porous cotton rock of the Cotter Formation causes it to become extremely dry during the summer and extended periods of drought. Trees have found it difficult to invade glade areas and a flora typical of rocky prairies is found there.

Alluvial Soils.—As previously stated, the alluvial soils are of minor importance in this survey. Small areas of the "first bottom," assigned to the Huntington Silt Loam, are included as well as the Elk Silt Loam which forms the soil of the ancient Meramec River terraces. Although those soils are not of sufficient extent to influence the development of a distinct forest type, they are interesting additions to the complex picture of the soils of the area.

LAND USE

It has not been possible to determine exactly what use has been made of this land since 1850, when the first titles were granted. Certain portions show evidence of early timber cutting, at least for local use, and certainly quantities of firewood were also cut. Some hilltops have been clear-cut with the expectation of farming. All the area must have been heavily pastured by open-range cattle. In more recent years more intense utilization followed the fencing of pastures and the change from open-range conditions. It is not possible to furnish dates at which certain areas were pastured or cut over. On the whole, the history has been one of intense usage. Very few mature, sound trees can be found, and it is assumed that many have been cut. Usually, following such operations the land was grazed and quite frequently it was burned.

The extent and purpose of the timber cutting depended largely upon the topography of the area. The valleys and the more gently sloping hillsides were within the capacity of the equipment available to the early settlers. One area is reported to have been a sawmill site, and the condition of the adjacent timber indicates that it may have been clear-cut (indicated on fig. 3 as "Logged more than fifty years ago"). A number of older trees escaped the axe, probably because of their low value. Some of the high hill land may have been clear-cut "Less than fifty years ago." The areas so designated are without old trees, and much of the younger growth appears to have originated from stump sprouts. One fairly large valley was cultivated prior to 1925, when the area was acquired by the Missouri Botanical Garden, and a similar area is to be found near one of the ridge tops.

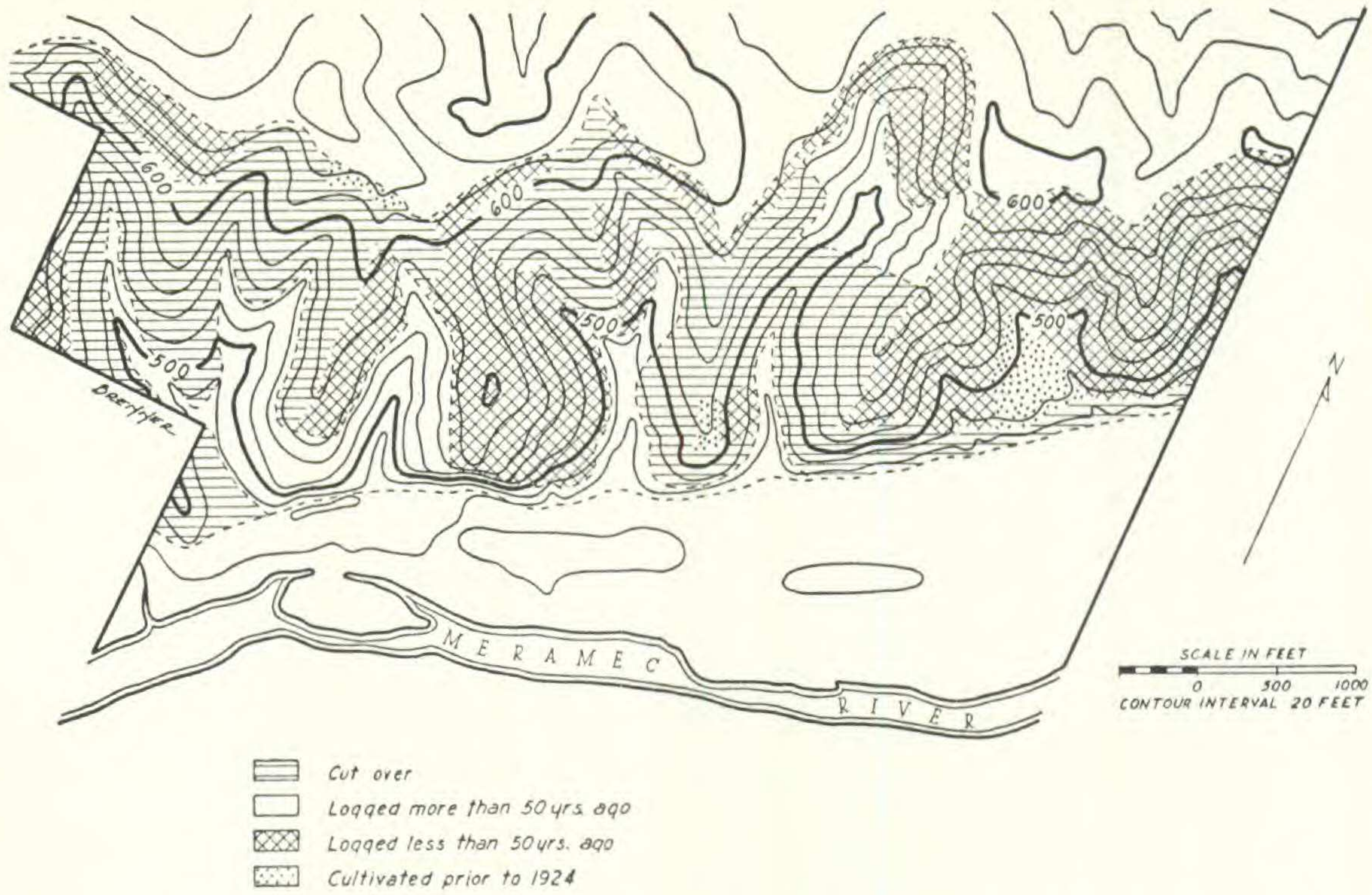

Fig. 3. History of land use of the Forest Preserve of the Arboretum.

The presence or absence of old trees may prove misleading when used as a measure of logging practices and land use. A few scattered old trees may indicate either that "selective" logging had been practiced—selective in the sense that the early settler cut certain trees for specific purposes—or merely that tremendous changes have occurred in the arboreal flora of the Ozarks in the last hundred years. Apparently, the Ozark forest today is more heavily stocked than it was a century ago, and the few relic trees to be found are those left from what was a park-like prairie (Schoolcraft, 1819) which seems to have been the outstanding characteristic of the region before 1850.

DEVELOPMENT OF TREE ASSOCIES DURING A TEN YEAR PERIOD

Anderson's forest-tree classification (1938) has been modified to conform to present usage (fig. 4). The tree species involved in each association were covered by Brenner (1942). The extent and location of the present forest tree associations are shown in fig. 5.

Post Oak-Black Jack Oak (Quercus stellata - Q. marilandica) Association.—This association is limited to isolated stations on the ridges and to the Union Silt Loam, and appears to be highly unstable. The decadent nature of this association and the rapidity with which it has been absorbed by the more vigorous Oak-Hickory association indicate the speed with which the hardwood forests are encroaching upon the early prairie associations.

White Oak-Sugar Maple (Quercus alba - Acer saccharum) Association.—Distribution of the Sugar Maple appears to be controlled by the presence of old fruiting trees, and definite edaphic relations of this member of the association are not

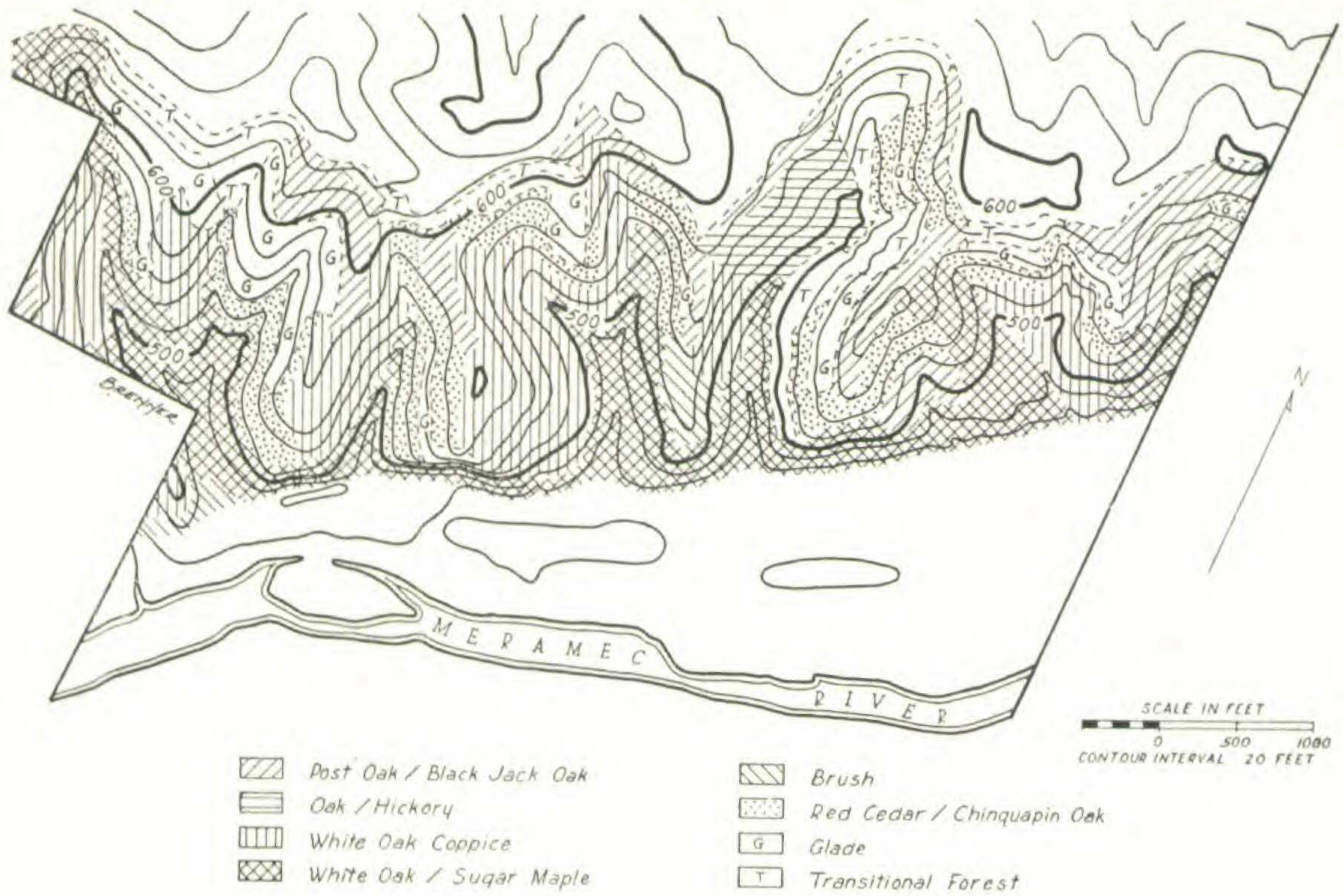

Fig. 4. Principal tree associations in 1938, Forest Preserve of the Arboretum. (From an unpublished field survey in 1938 by Edgar Anderson.)

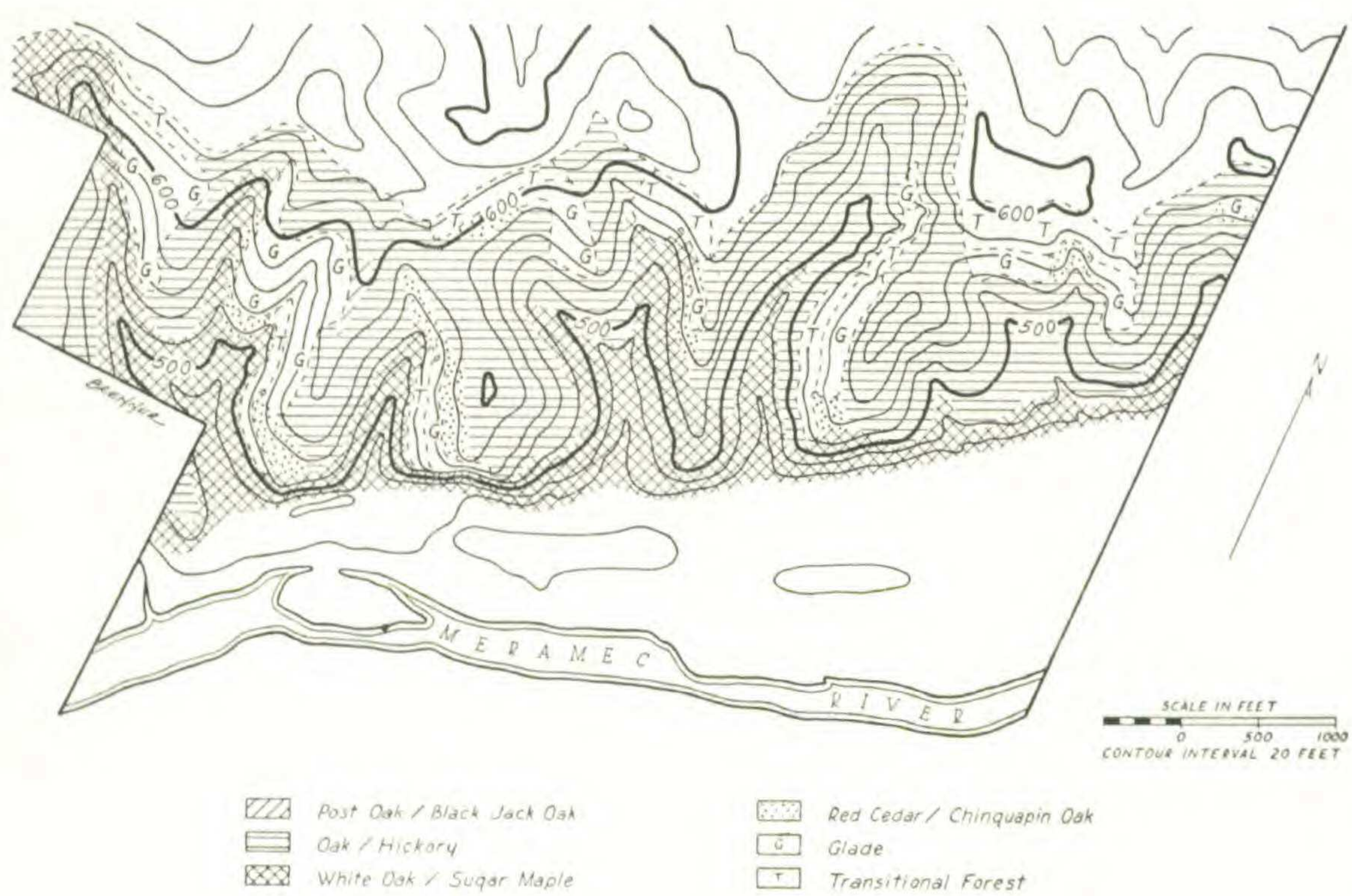

Fig. 5. Principal tree associations in 1948, Forest Preserve of the Arboretum.

shown. The rapid and widespread regeneration of the Sugar Maple in the deep moist valleys is apparently conditioned by the more favorable microclimate of those sites. In 1938 this association included several valleys where some selective cutting had been done in the last fifty years, but no clear-cutting for at least a hundred years. Such cutting and the resultant openings in the forest favored the rapid growth of the Sugar Maple. At present, however, it is losing its position as a codominant and may eventually disappear from this association. Above the valley floor the changes have been more rapid. The Sugar Maple in the White Oak-Sugar Maple Association of 1938 has been succeeded by hickory, and these areas are now classed as belonging to the Oak-Hickory Association.

Oak-Hickory (Quercus alba, Q. borealis, Q. stellata-Carya ovalis, C. ovata, C. tomentosa, C. Buckleyi) Association.—The high commercial value of these species, their rapid regeneration, and good annual increment make this forest association particularly important to foresters. The marked adaptibility of these trees permits almost cosmopolitan distribution, for little preference is shown toward rock, soil, or direction of slope. However, the association has been most consistently mapped on areas of the Union Silt Loam where greater depth of soil and concurrent fertility have favored rapid growth and excellent regeneration. Perhaps no other tree association has had more continual exploitation. There is ample evidence that the trees have long been regarded as a source of firewood, rough lumber, and railroad ties, and such great use was made of them that in 1938 the Oak-Hickory Association was one of the least extensive in the area. However, it is becoming increasingly vigorous under the present system of land management and at present about 60 per cent of the area falls in this class. The Red Oak *(Quercus borealis)* and the important Shumard Red Oak *(Q. Shumardi)* are invading these associations and are becoming codominant with the White Oak.

White Oak Coppice (Quercus alba).—The White Oak Coppice is shown on the early map to cover about 20 per cent of the area. Nearly all of this is now included in the Oak-Hickory Association, with the Red Oak an important tree of the understory.

Red Cedar-Chinquapin Oak (Juniperus virginiana-Quercus Muhlenbergii) Association.—This association is unique in being the only one of the area which is closely correlated with the underlying rock strata. On the accompanying maps (figs. 1, 4, 5) the Red Cedar-Chinquapin Oak Association is seen immediately bordering the cotton rock both above and below its extensive outcroppings on the western slopes. In this narrow belt, often a mere rod or two broad, the influence of the cotton rock still excludes other forest types. This association is shown to be more extensive on the map for 1938, since at that time accelerated erosion induced by earlier logging and pasturing only served to cause a more widespread effect of the conditions induced by the cotton rock. Rapid growth of the Red Cedar and its remarkable powers of regeneration have caused it to be exploited greatly as a source of fence posts and telephone poles within the past fifty years. Today the association has a more limited distribution, and the Oak-Hickory and White Oak-Sugar Maple associations have apparently invaded much of its outlying portions.

Glade Association.—Here the inherent properties of the cotton rock in conjunction with a western exposure of slope have combined to form a critical zone for the growth of trees. Trees are conspicuously absent, an herbaceous, prairie-like flora prevailing.

Transitional Forest.—Because of its heterogenous composition and lack of aged specimens, the Transitional Forest is considered to be in a state of flux. Intensive exploitation of these sites through pasturing and logging has created a long-enduring juvenile state where the soil mantle is poorly defined. Comparison of the maps of early and present tree associations (figs. 4, 5), and the soil map (fig. 2) shows this association to be closely correlated with the Undifferentiated Forest Soil. Recent survey of the area shows the invasion of the Transitional Forest by Oak-Hickory and White Oak-Sugar Maple associations as the site matures and a deeper soil mantle protected by a layer of forest litter is developed.

Brush.—Several small areas classed as "Brush" in 1938 are now included in the White Oak-Sugar Maple Association. In 1938 those areas contained much sassafras *(Sassafras albidum)*, elm *(Ulmus* sp.*)*, and sumac *(Rhus copallina)*, and were considered as not likely to persist. They are now stocked with some of the best young timber.

SUMMARY

Because studies in the natural succession of forest trees in the Ozark region of Missouri have been based largely upon site-to-site comparisons it is felt that this work, founded upon actual observations of the same area over a ten-year period, will give a better understanding of forest tree succession in the northern Ozarks region. Considerable attention has been given to both the rocks and the soils, since these have been observed to play important roles in the distribution of certain tree associations which may obtain only in similar areas. The history of land use of the area is reviewed, since the activities of man, in his pursuit of a livelihood in forestry and agriculture, may have altered the natural succession of forest trees.

This time-lapse study indicates a rapid invasion of valuable timber species such as Red Oak, White Oak, and White Hickory. The Black Jack Oak-Post Oak, and White Oak-Sugar Maple associations have been invaded by these vigorous species and will be dominated by them, indicating a future invaluable source of high-grade timber species in this area.

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